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A National Energy Program for Forestry

Contents

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The Potential for Energy Development

Wood is a renewable resource that with proper management could provide significant amounts of energy indefinitely. Energy available from wood could be increased by intensified application of silvicultural practices and by wiser utilization of resources by consumers.

About 1.3 quads[1], over 1.5 percent of the 80 quads of energy used annually in the United States, comes from wood and wood byproducts. By 1990, an additional 5 quads could come from currently unused forest biomass, providing markets for surplus tree growth, logging residues, material removed in cultural and management activities, processing residues, and urban wastes. This estimate of 5 quads is based on the assumption that one-half of the currently unused biomass could be recovered economically and that this recovery would have favorable environmental impacts. Technology developed in the next 10 years will improve the potential for economically feasible utilization of even more of the biomass resource in the decades that follow.

The production and conservation of energy in all forms is a national goal of the highest importance. The utilization of forest biomass for energy is an important component of that goal. This brochure describes a national energy program for forestry proposed by the Forest Service, U.S. Department of Agriculture, in terms of major goals, objectives, needs that must be met, and actions proposed to meet these needs.

The information presented here should provide forestry professionals, political leaders, and others concerned with energy problems and wise management of our resources a basis for making decisions and investments to promote the use of forest biomass for energy.

The implementation of a forest biomass energy program requires the involvement of many user and problem-solving groups. Federal and State governments and agencies, universities, private consulting firms, research organizations, industry and trade and dealer associations must communicate and coordinate efforts to achieve objectives in the most economical manner. Research must support development and application (putting discoveries to use) with minimal duplication of effort. Application efforts must support market development, and technical assistance must be available to landowners and wood producers. A concurrent extension program for landowners, wood producers, and potential users should be

[1] 1 quad = 1 quadrillion = 1×10^{15} = 1,000,000,000,000,000, Btu's.
1 Btu = the quantity of heat required to raise the temperature of 1 pound of water 1 degree Fahrenheit at or near 39.2° F.

available to provide guidance and information on new technology, safe practices, and where to go for assistance to assure responsible development of the use of wood for energy.

The approaches to utilizing wood for energy will vary by geographic region based on the potential markets and wood available for energy purposes. For example, in the Northeast there is an increasing demand for hardwood thinnings for use as home fuelwood. In the South, there is an expanding market for wood to fuel small industrial plants. In the West, large volumes of logging residues are being considered for electrical generating plants. In most regions of the country, wood fuel has its best immediate market in the forest industry mills and plants. Success in assuring the appropriate contribution of wood for our national energy needs will depend on the effectiveness of the coordination discussed above. Innovative approaches will be needed to attract potential users and establish reliable supply systems.

Considerable technical data are available on the management of forests, the harvest and transport of forest products, and the use of wood as a fuel. Many technical reports are available on conservation of energy and the wise consumer use of wood. The environmental quality control employed by forest managers, plus increased efforts by research, provide a sound basis for proceeding immediately to encourage the increased use of wood for energy. While there are many applications where wood can be put to energy pro-

Fuelwood is again a major product of America's forests.

duction with current technology, there are gaps in knowledge and equipment needs that must be satisfied by research before the full benefits of energy from wood can be realized.

After an analysis of the Nation's forest biomass resources, this brochure presents the Forest Service's proposed forest biomass energy program. It ends with a reminder of the difficulty in coordinating a national program and the need for cooperation and involvement of all the user and problem-solving groups in working to achieve a practical contribution from forest biomass to this Nation's energy needs.

Our Forest Biomass Resources

Forest biomass includes all aboveground and belowground tree and woody shrub material. The estimates in this brochure, however, represent only the aboveground portions of the biomass.

Forest inventory practices have measured only trees 5 inches in diameter at breast height—54 inches above ground level—to determine the volume in the bole. Volume in other parts of the tree and smaller trees was not reported in forest statistics. Studies to determine whole tree weights and volumes have been made for only a few species. Therefore, the total biomass figures presented in this brochure are only estimates.

Wood fuel storage for industrial use requires considerable space.

The data definitely indicate, however, that there is much more forest biomass than is needed to meet current and projected demands for conventional wood products. This extra biomass can be used to produce energy. Removal and sale of this material offers significant management benefits. For these reasons, forest land managers should be interested in developing biomass energy markets and seeking technology to improve the competitive position of forest biomass in energy and chemical markets.

A significant portion of the estimated 600 million dry tons of currently unused forest biomass is available annually for energy and other new uses at most recently reported (1977) levels of growth and production of forest products. Logging residues and standing trees on harvested areas account for 180 million dry tons. Excess growing stock and mortality (dead trees) on commercial forest land account for 310 million dry tons. The rest of the 600 million dry tons comes from the land and right-of-way clearings, wood processing wastes, urban tree removals, and wood-based trash. This total unused forest biomass could produce approximately 10.2 quads of energy—the equivalent of 1,675 million barrels of oil annually (table 1).

Many complications must be overcome to recover the unused biomass. Forest sources are diverse in species, size, character, terrain, and location with respect to potential markets. Urban residues are concentrated but are mixed with metals, plastic, household refuse, and other materials that must be segregated to provide a

Logging residues could contribute 180 million dry tons of forest biomass every year for energy use.

Table 1.—*Estimated unused wood available annually for energy in the United States[1] and energy equivalent[2]*

	Forest biomass		Energy equivalent
	Weight	Energy	Oil
	Million dry tons	*Quads*	*Million barrels*
Forest			
Harvest sites:			
Logging residues from growing and nongrowing stock	160		
Standing live and dead trees	20		
Commercial forest land:			
Excess growing stock	215		
Mortality	95		
Total, forest	490	8.3	1.360
Urban			
Tree removals and wood wastes	70	1.2	200
Other			
Forest products industrial waste	20		
Waste wood from land clearing	20		
Total, other	40	.7	115
Total, all sources	600	10.2	1,675

[1] Based on resource data from *Forest Statistics of the U.S., 1977,* U.S. Department of Agriculture, Forest Service.

[2] Based on 145,000 Btu/gal.

uniform energy raw material. Most of the unused forest industry waste is found at small primary and secondary plants. The ability to recover portions of this unused biomass economically is still to be proved. Nevertheless, it is assumed that technology for recovering perhaps 50 percent (300 million dry tons) of this resource could be implemented by 1990 with a dedicated research, development, and application effort. This is enough biomass, added to the current use of wood for energy, to produce 6.4 quads of energy from wood (table 2).

Excess growing stock and mortality on commercial forest land—a 310-million-tons-per-year currently untapped resource.

Wood processing waste—a 20-million-tons-per-year resource.

Table 2.—*1990 annual production objective for forest biomass*

	Forest biomass		Energy equivalent
	Weight	Energy	Oil
	Million dry tons	*Quads*	*Million barrels*
New production by 1990	300	5.1	835
Current production for energy:			
Forest industries	60	1.0	165
Residential and other	18	.3	50
Total	378	6.4	1,050

Proposed Framework for a National Program

Energy goals established by the U.S. Department of Agriculture formed the basis for the Forest Service's forest biomass energy program described in this brochure. In establishing objectives for the program, the Forest Service identified needs and actions to reach the objectives.

Goals

In 1976, the U.S. Department of Agriculture identified the following goals to help solve the Nation's energy problems:

1. Assure energy supplies for essential food, fiber, and forest production.

2. Provide maximum support to short- and long-term energy conservation.

3. Develop the energy potentials of biological materials and wastes.

4. Facilitate the environmentally sound development of energy reserves of coal and other resources on Federal lands.

In 1979, the Secretary of Agriculture identified a fifth USDA goal—support activities to assure that agriculture and forestry become energy self-sufficient by 1990.

Objectives
To help attain these energy *goals* of the U.S. Department of Agriculture, the Forest Service proposes a forest biomass energy program with the following *objectives:*

1. Production annually of 6.4 quads of energy from forest biomass by 1990.

2. Conservation annually of 2.0 quads of energy by 1990 through improved efficiency in the production and use of wood products.

3. Development and implementation of environmental protection guidelines in connection with production and use of wood for energy.

Production. To meet the production objective, we need to consider the following five categories of needs:

1. *Current and accurate resource information.*—Current inventory procedures do not measure total biomass. We need more accurate estimates on biomass available by class of material and location. Measurement of total biomass must be incorporated into traditional inventory procedures. We also need methodologies for measuring and determining the volume of biomass and converting current data to biomass weights. Techniques to estimate biomass weights for site-specific feasibility studies need to be developed.

To meet these needs the following *actions* are proposed:

- Develop techniques to measure and classify biomass and prepare volume and weight tables.

- Prepare regional biomass estimates and identify the best potential uses.

- Incorporate biomass volume and weight measurement into inventory procedures.

- Develop regional wood supply and demand models.

2. *Improved forest management.*—Current productivity on commercial forest lands is far below the potential. A much greater effort is needed to transfer existing forest management knowledge to both large and small landowners. Research is needed to improve our knowledge of management alternatives especially related to energy products.

To meet these needs, the following *actions* are proposed:

- Identify and develop silvicultural and management techniques for maximizing biomass production in natural stands.

- Increase the information base for species adaptable to intensive-culture, short-rotation forestry.

- Establish test plantations of selected species.

- Increase technical assistance to private forest landowners.

3. *Recovery of forest biomass.*—Increasing productivity of our forests is of little value unless the wood is harvested, processed, and delivered to the user at a reasonable or competitive price. Current equipment and systems were designed principally for large and relatively uniform logs and cannot be expected to recover efficiently much of the existing forest residues. We need considerable testing and modification of current equipment and systems, coupled with research and development of new equipment and systems to recover large volumes of wood economically. Timber sale procedures need to be modified and new approaches to contracting for stand improvement and fire prevention practices need to be developed. Also essential are programs to encourage wise production of fuelwood from private lands.

Small, maneuverable machinery like this is needed for mechanizing thinning and stand improvement work.

To meet these needs, the following *actions* are proposed:

- Test various configurations of systems that use existing equipment to establish a cost base for harvesting and transportation.

- Develop and test new and modified equipment to improve efficiency in handling residues and small trees.

- Identify and describe specific sites, stands, and conditions requiring special logging systems and equipment.

- Develop specialized equipment and systems.

- Develop and implement improved in-woods processing and transportation systems.

- Develop and implement improved processing, handling, drying, and storing systems.

4. *Substitution of petrochemicals and fuels with biomass-derived counterparts.*—Most of our critical consumer industrial chemicals are derived from petroleum. Fuels essential for our transportation systems also come from petroleum. We need to find substitutes so that we can reduce our reliance on foreign petroleum. Basic and applied research is needed so that conversion

This machine prepares an 8-foot-wide, 1-mile-long strip for replanting while converting debris into usable chips as it moves along.

A mobile chipper converts whole trees into chips for better utilization.

of forest biomass to chemicals and alcohols can become economically feasible.

To meet these needs, the following *actions* are proposed:

- Develop energy-efficient methods to improve the yield of alcohol from wood.

- Develop procedures for increasing the feasibility of producing alcohols at pulp mills.

- Conduct basic research to develop petrochemical substitutes such as adhesives from wood and bark.

- Expand the use of technology for increasing the production of oleoresin from southern pines.

- Develop improved pyrolysis systems for producing oil, gas, and charcoal.

- Establish alcohol pilot plants to utilize wood biomass as the primary feedstock and/or fuel.

- Establish small-scale pilot plants and distribution systems for on-farm or community production of alcohol from biomass.

5. *Stimulating increased use of wood fuel.*—Heating the home with wood is different from what it used to be in the late 1800's. Today, we need to consider new designs for circulatory heating systems, homes unoccupied for 8 to 9 hours at a time, much higher prices for wood, stringent building codes, and potentially higher insurance rates.

The use of wood by industry must consider other factors, such as large fuel supply requirements, meeting environmental concerns, costs, methods for handling of large volumes of material, facilities for burning nonuniform fuel—such as forest biomass, unused mill waste, and urban and land clearing residues—and systems for collecting these residues economically.

To meet these needs, the following *actions* are proposed:

- Identify specific market opportunities for unused wood and develop strategies to attract the interest of these markets.

- Develop and implement reliable merchandising schemes to supply the growing demand for residential fuelwood.

- Develop efficient and convenient residential heat plants.

- Develop reliable wood gasifiers.

- Develop improved handling and processing procedures for biomass feedstock.

- Develop guidelines for the safe installation and use of home wood burning appliances.

Conservation. The conservation of energy in all activities, from the establishment of forest stands to the use of forest products by the consumer, can save significant amounts of energy. The proposed options, if adopted, could result in saving 2 quads of energy annually by the year 1990.

To meet the conservation objective, we need to meet the following five categories of needs:

1. *Substitution of wood for other materials.*—Because of the low cost of energy in the past, the relative importance of wood as a consumer material compared to aluminum, steel, and plastics declined. For comparable uses, forest products require less energy to process than most materials. The energy equivalent of 0.2 ton of coal is consumed to process a ton of wood product compared to 10 tons coal for a ton of aluminum or 6 tons coal for a ton of plastic. We need research on the feasible substitution of wood for high energy-cost materials.

To meet this need, the following *actions* are proposed:

- Identify opportunities to substitute wood and wood-based products for energy-intensive materials in construction.

- Develop new products that reduce the need for energy-intensive materials.

- Provide technical assistance to promote the wise and safe use of wood and paper products.

2. *Light-frame construction.*—Frame construction usually exceeds the performance standard needed in home construction. New techniques that can reduce the consumption of framing wood in construction by as much as 30 percent have been developed. We need technical assistance programs that promote adoption of lumber and energy-saving technology that contributes to significant conservation of energy without sacrificing integrity of the structures.

To meet these needs, the following *actions* are proposed:

- Develop engineering guidelines for the appropriate use of wood in homes.

- Develop new concepts for light-framed construction in large structures.

- Assist code writers in incorporating new technology into building codes.

- Implement a technical assistance program for builders and developers.

3. *Efficient management, harvesting, and transport.*—We need research and technical assistance programs to promote savings in the harvesting of forest biomass and the transport of wood products. Several energy-efficient harvest systems have been developed that have economic effectiveness and low environmental impact; putting this technology to work through technical assistance programs would reduce the amount of energy required for harvesting.

To meet these needs, the following *actions* are proposed:

- Develop energy-efficient alternatives to decrease fuel consumption in site preparation, planting, and management of forest stands.

- Develop energy-efficient systems to harvest and transport wood.

• Provide technical assistance to private landowners on energy-efficient management techniques.

4. *Weatherization of buildings.*—Programs are needed to promote home weatherization. The use of cellulose-derived or fiberglass insulation can reduce significantly the energy required for home heating and cooling. Steps taken to reduce infiltration of air can have equally dramatic results. Installation of wood storm doors and windows can further reduce energy drain.

To meet these needs, the following *actions* are proposed:

• Provide designs for structures that incorporate the use of solar energy.

• Provide structural designs to maximize insulating characteristics of wood and wood products.

• Assist in development and implementation of incentive programs where needed.

• Provide technology transfer to implement energy-saving techniques in new and older structures.

5. *Efficient processing of wood products.*—The possibility for improving energy efficiency in processing of wood products is demonstrated by the Forest Service Sawmill Improvement Program (SIP), which has resulted in increased lumber recovery from logs. Research is underway to reduce the energy consumption in pulp and papermaking processes. We need similar programs to improve efficiency in milling, drying, and secondary manufacture. Implementation of these programs could result in substantial energy savings by 1990.

To meet these needs, the following *actions* are proposed:

• Improve energy efficiency in converting wood to pulp, paper, lumber, and reconstituted wood products.

• Reduce fossil based energy consumption through solar energy techniques and utilization of waste heat.

• Improve lumber yields through improved harvesting and sawing methods.

Environmental Protection. Increased production of wood for energy need not be made at the expense of environmental quality. The increased use of wood for energy offers positive forest management benefits. The reduction in the volumes of logging residues will

Accurate measurement of logs and lumber and a Forest Service Sawmill Improvement Program permit mills to improve lumber output per log by 10 percent and more.

decrease the slash-related fire problem. The thinning of timber stands will increase the growth rate and productivity and shorten the rotation period for pulp and sawlog production. However, research has not fully evaluated the results of increased removal of biomass. We need hard facts concerning the impact on soil, water, wildlife, and other amenities of the forest ecosystem that results from increased utilization of wood from different forest sites. We also need to know more about the potential pollution problems that can result from the increased use of wood stoves in homes. Technical assistance is needed by landowners and wood producers so that environmentally sound land management and cutting practices are used.

To meet these needs, the following *actions* are proposed:

- Accelerate research to develop environmental guidelines for the management of the different forest types and sites that will be harvested for energy wood.

- Increase the technical assistance available to small landowners.

- Develop efficient wood burning systems to reduce the adverse effects on air quality.

- Initiate public information programs on forest management and the efficient use of wood directed at landowners, commercial firewood producers, and users.

Making It Work

Coordination of a national program is difficult. Duplication can never be fully eliminated, nor do we believe it should be. Our Nation's economic vitality is based on the free enterprise system that is created by building, marketing, and selling competitive products. A combination of Federal and State agency, university, and industry efforts in developing better approaches to using wood for energy is healthy. Parallel approaches to problem solutions are common in every scientific and product field.

However, the efforts of several organizations should be oriented toward those areas where the maximum impact of wood for energy can be made. Interchange between the principal scientists, technology transfer specialists, and user groups should be stimulated. Common goals may be identified in an attempt to maximize the contribution wood might make to our energy needs.

The three objectives presented—production, conservation, and environmental protection—represent a wide spectrum of investigative potentials and problems when wood is considered as an energy source. Investments in technical assistance and research and development programs will be required to achieve the goals outlined. However, the costs are small compared with the short- and long-term gains resulting from the reduced dependence on imported oil and gas, reduction in energy costs and balance-of-payment deficits, stability in rural economics, and the potential for improved forest management and productivity.

The USDA Forest Service intends, by distribution of this brochure, to provide better focus on the goals and objectives that our Nation's research, development, and application organizations and others should address on the wood-for-energy issue.

October 1980